Revising Criteria for Chloride, Sulfate and Total Dissolved Solids

By revising Iowa's water quality standards, the Iowa Department of Natural Resources (DNR) is working for improved water quality and safety in Iowa. Water Quality Standards are the goals that we set for Iowa's streams, rivers and lakes.

Water Quality Standards have three components:

- Designate the use or uses of the waterbody (aquatic life and recreational uses)
- Set the criteria for protecting those uses
- Protect and maintain existing water quality

Recently, the DNR began to compile all research related to toxicity of total dissolved solids, chloride and sulfate. The purpose was to update and develop criteria for these parameters to better protect aquatic life based on new scientific information.

The DNR worked with the U.S. Environmental Protection Agency to ensure that the research compiled met certain scientific standards. Gaps were identified in the research and resulted in new toxicity tests being performed in 2008.

With the availability of new research and toxicity data, the information is now available to propose numeric criteria for chloride and sulfate to better protect river, stream and lake aquatic life uses and revaluate the current interim approach for total dissolved solids criteria.

Chloride Criteria

Results of the research and toxicity testing completed for chloride showed that chloride toxicity is heavily dependent on water hardness, and to a lesser degree, sulfate levels in the water. Using all of the literature and this most recent toxicity testing, EPA developed an equation (see below) for the acute and chronic chloride criteria to protect Iowa's waters.

Proposed chloride criteria

To calculate the applicable acute and chronic criteria for chloride use equations below. Statewide default values for hardness and sulfate will be used unless site specific data is available.

Acute Chloride Criteria Equation

$254.3(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452}$ = Acute Criteria Value (mg/L)

Chronic Chloride Criteria Equation

$161.5(\text{Hardness})^{0.205797}(\text{Sulfate})^{-0.07452}$ = Chronic Criteria Value (mg/L)

The following statewide background values were determined by analyzing DNR ambient water monitoring data from 2000 to 2007:

- Hardness: 200 mg/L as $CaCO_3$
- Sulfate: 63 mg/L
- Chloride: 34 mg/L

For example, if a Hardness value of 200 mg/L and a Sulfate value of 63 mg/L are used:

The acute criteria value for chloride would be:
$254.3(200\ \text{mg/L})^{0.205797}(63\ \text{mg/L})^{-0.07452}$
= 556 mg/L Chloride

The chronic criteria value for chloride would be:
$161.5(200\ \text{mg/L})^{0.205797}(63\ \text{mg/L})^{-0.07452}$
= 353 mg/L Chloride

Sulfate Criteria

In 2005 and 2006, the State of Illinois worked with U.S. EPA to complete a review of research related to sulfate toxicity

Chloride is a major ion commonly found in streams and wastewater. Chloride may get into surface water from several sources, including:

- Wastewater from certain industries
- Wastewater from communities that soften water
- Road salting
- Agricultural runoff
- Produced water from oil and gas wells

similar to the work done for chloride. The result of that work was a proposed criteria equation for sulfate based on background hardness and chloride levels. The similarities between the landscape and waterbodies of Iowa and Illinois and the high level of scientific review of this data allow for the same sulfate criteria proposed by Illinois to apply to protect aquatic life in Iowa's waters.

The proposed sulfate criteria also incorporates an upper limit of 2,000 mg/L to ensure that other beneficial uses of the waterbody, such as livestock watering, are protected in addition to aquatic life.

Total Dissolved Solids

The current interim approach for total dissolved solids levels through Whole Effluent Toxicity Testing will be replaced by the proposed criteria for chloride and sulfate.

This revision is based on scientific review that demonstrates individual ions cause toxicity to aquatic life. This review revealed that in Iowa, chloride and sulfate are the specific ions of concern.

As a result, ion criteria for chloride and sulfate are better indicators than integral parameters such as TDS, conductivity and salinity for water quality protection.

Proposed Sulfate Criteria for Iowa Waters

The results of the following equations provide sulfate water quality standards in mg/L for the specified ranges of hardness (in mg/L as $CaCO_3$) and chloride (in mg/L) and must be met at all times:

- If the hardness concentration of waters is between 100 mg/L and 500 mg/L and if the chloride concentration of waters is between 25 mg/L and 500 mg/L:

  [1276.7 + 5.508 (hardness) – 1.457 (chloride)] * 0.65

- If the hardness concentration of waters is between 100 mg/L and 500 mg/L and if the chloride concentration of waters ranges between 5 mg/L and up to 25 mg/L:

  [-57.478 + 5.79 (hardness) + 54.163 (chloride)] * 0.65

The following sulfate standards must be met at all times when hardness (in mg/L as $CaCO_3$) and chloride (in mg/L) concentrations other than specified are present:

- If the hardness concentration of waters is less than 100 mg/L, or chloride concentration of waters is less than 5 mg/L, the sulfate standard is 500 mg/L.

- If hardness concentration of waters is greater than 500 mg/L, the sulfate standard is 2,000 mg/L.

PROPOSED SULFATE CRITERIA FOR IOWA WATERS

Chloride / Hardness mg/L as $CaCo_3$	Cl- < 5 mg/L	5 ≤ Cl- ≤ 25	25 < Cl- ≤ 500
H < 100 mg/L	500	500	500
100 ≤ H ≤ 500	500	[-57.478 + 5.79 (hardness) + 54.163 (chloride)] * 0.65	[1276.7 + 5.508 (hardness) – 1.457 (chloride)] * 0.65
H > 500	500	2,000	2,000

Total Dissolved Solids is a measure of all constituents, or elements, dissolved in water. This can include inorganic anions (negatively charged ions) like carbonates, chlorides, sulfates and nitrates. The inorganic cations (positively charged ions) include sodium, potassium, calcium and magnesium.

Sulfate is a constituent of TDS and may form salts with sodium, potassium, magnesium and other cations. Sulfate is widely distributed in nature and may be present in natural waters at concentrations ranging from a few to several hundred milligrams per liter.

For more information:

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